Heart rate responses during simulated fire ground scenarios among full-time firefighters

Johnson, Quincy; Goatcher, Jonathan; Lockie, Robert G.; Orr, Rob Marc; Alvar, Brent; Smith, Doug; Dawes, Jay

HEART RATE RESPONSES DURING SIMULATED FIRE GROUND SCENARIOS AMONG FULL-TIME FIREFIGHTERS

[1]Quincy R. Johnson M.S., [2]Jonathan D. Goatcher MSc, [3]Robert G. Lockie PhD, [4,5] Robin M. Orr PhD, [6]Brent Alvar PhD,, [1]Doug B. Smith PhD, [1]J. Jay Dawes PhD

[1] Department of Health and Human Performance, Oklahoma State University, Stillwater, OK, USA; [2] Athletic Department, United States Air Force Academy, Colorado Springs CO., USA; [3] Department of Kinesiology, California State University, Fullerton, Fullerton, CA, USA; Bond Institute of Health & Sport, Bond University, Gold Coast, QLD, Australia; [5] Tactical Research Unit, Bond University, Gold Coast, QLD, Australia; [6] Department of Kinesiology, Point Loma Nazarene University, San Diego, CA.

OSUNeuro Applied Neuromuscular Physiology Laboratory

Abstract

Simulated fire ground scenarios (SFGS) provide firefighters an opportunity to maintain their skills and receive team feedback in order to optimize their performance. Although there is extensive research on heart rate (HR) changes in the firefighter population, very few have examined these differences between positions. **Purpose/Objective:** To quantify the physical demands of SFGS among Firefighting crews by position through HRV analysis. **Methods:** Sixty-eight male (age: 38.97 ± 9.17; ht: 177.99 ± 6.45 cm. wt: 88.83 ± 13.55 kg) firefighters volunteered to participate in this research. Firefighting crews performed two SFGS involving the suppression and control of a structural fire, while wearing personal protective equipment (PPE) and using a self-contained breathing apparatus (SCBA). Subjects were outfitted with heart rate (HR) monitors and weighed immediately prior to performing a SFGS. Average heart rate (HRavg) and maximum heart rate (HRmax) data was collected and recorded for each of the two scenarios performed by each crew. **Results**: During SFGS it was discovered that HRavg ranged between 54 – 88% (of APMHR and average HRmax ranged between 73– 106% of APMHR. **Conclusions:** SFGS are very physically demanding events that may elicit maximal or near maximal heart rate responses regardless of positon. **Practical Application**: Based on the metabolic demands of these events and the individual firefighter's capabilities, this information can be used to develop conditioning programs that optimize performance at maximal or near maximal heart rates.

Introduction

Firefighting is a hazardous profession that often exposes firefighters, drivers, officers, and paramedics to unpredictable conditions. In addition to the unpredictability of the profession, these men and women, whether volunteer or full-time, are expected to perform their jobs efficiently and effectively under high amounts of physical stress. Before, during, and after emergent situations acute and chronic changes to firefighters internal environments contribute to the high rates of cardiovascular diseases (CVD) that we see in the firefighter population today. Due to the stresses of the profession, cardiovascular events such as myocardial infarction (heart attacks) and coronary artery disease are the leading causes of death among firefighters [1,2,3,4,5,6]. In an effort to better understand the firefighting population, the demands of their job, and the CVD incidence, a growing body of research has been focused on investigating cardiovascular health risks, and changes in internal loading, specifically, heart rate (HR) measures during firefighting and simulated fire ground scenarios (SFGS)[1,2,3,4,5,6]. SFGS are essential to the profession of firefighting and provide firefighters an opportunity to maintain their skills and receive team feedback in order to optimize their performance.

Purpose

The purpose of this study was to compare differences in heart responses during a SFGS between firefighters, drivers, officers, and paramedics. We hypothesized that there would be significant differences in HR between positions during SFGS.

Methods

Sixty-eight (n=68) male firefighters (age: 39.00 ± 9.14; ht: 178.08 ± 6.46 cm. wt: 88.87 ± 13.47 kg) volunteered to participate in this research investigation. Volunteers were outfitted with Polar heart rate monitors (Polar Electro Oy, Kemple, Finland) prior to the beginning of the SFGS. After completion of each SFGS, the firefighters re-grouped and stopped their monitors. Measures of HRavg and HRmax were recorded for both scenarios. All data recording was initiated and terminated within three minutes of starting and finishing SFGS. A total of two simulations were completed, both of which involved the suppression and control of a structural fire. Firefighters were subdivided by position and each measure was then analyzed by position, group demographics can be found in Table 1. For statistical analysis, A one-way ANOVA was utilized to determine if significant differences existed in HR between positions. A Tukey's post hoc analysis revealed no significant differences in HRavg and HRmax by position.

Table 1. Group Demographics

Position	n	Age	Height	Weight
Driver	11	42.72 ± 8.32	177.91 ± 9.97	95.68 ± 19.29
Firefighter	36	35.36 ± 8.14	178.25 ± 6.22	87.00 ± 11.30
Officer	11	47.80 ± 5.79	176.75 ± 4.77	89.40 ± 15.66
Paramedic	10	39.18 ± 9.42	178.91 ± 4.68	87.68 ± 10.56

Results

Mean and standard deviations for descriptive statistics and each variable measured are presented in Table 2. No Significant differences were observed for HRavg or HRmax between team position.

Table 2. Mean ± SD for average heart rate (HRavg) and maximum heart rate (HRmax) for each firefighter role delineation during SFGSs.

Position	HRavg	HRmax
Drivers	0.710 ± 0.081	0.945 ± 0.106
Firefighters	0.722 ± 0.076	0.926 ± 0.059
Officers	0.695 ± 0.061	0.892 ± 0.059
Paramedics	0.717 ± 0.066	0.934 ± 0.050
P	> 0.05	> 0.05

Conclusions

Although this study observed no significant differences in HRavg or HRmax between groups, we can provide a few key take home messages. SFGS are very physically demanding events that may elicit maximal or near maximal heart rate responses regardless of positon. Based on the metabolic demands of these events and the individual firefighter's capabilities, this information can be used to develop conditioning programs that optimize performance at maximal or near maximal heart rates.

Practical Applications

Tactical Strength and Conditioning Facilitators should develop focused conditioning programs that address the metabolic and physical needs of the activities a firefighter regularly experiences on duty. Manipulating the frequency, intensity, time, type, volume, and progression (FITT-VP) of exercises within conditioning programs may optimize job performance, metabolic responses, and physical preparedness in the firefighter population.

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